Public and Active Transport Planning for Resilience and Health:
The Case of Seoul, South Korea

Case Study
Leaders in Urban Transport Planning (LUTP) Program

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Declared a global pandemic by the World Health Organization (WHO) in March 2020, COVID-19 has prompted cities around the world to consider more holistically the relationships among public health, transportation system resilience, and quality of life. The pandemic demonstrated diverse linkages between transport and health and spotlighted the vulnerability of connected, mobile, global societies to disease.[1]

- When it comes to transport and public health, pre-COVID discussions often focused on accessibility to healthcare and linkages between air pollution (from vehicles) and respiratory health. COVID-19 has added a critical new dimension to these conversations: the health of travelers in urban transport systems.
- When it comes to transport and resilience, pre-COVID discussions often focused on the adaptation of transport infrastructure—such as roads, rails, and bridges—to natural hazards. COVID-19 and the need to transport essential workers throughout the pandemic have additionally highlighted the importance of efficient and safe transport as a critical contributor to the resilience of all urban systems to economic, social, epidemiological, and natural shocks, including financial crises, pandemics, and natural disasters.

Resilience is the ability of an urban mobility system to withstand, respond to, and recover quickly from shocks such as natural disasters, financial crises, or global pandemics such as COVID-19.

In South Korea, the Seoul Metropolitan Government (SMG) has undertaken a number of measures that have strengthened the resilience of their urban transport system over time. Beginning in the early 2000s there was a change in mindset among officials in the SMG. Realizing that building more roads and highways was taking up valuable urban space, contributing to unaesthetic and unhealthy communities, and not alleviating Seoul's congestion, they decided to address the underlying issue of growing demand for car trips by providing high-quality alternatives. The SMG decided to invest in public transit as the backbone of this more people-focused system, building out a new metro system. In 2004, the SMG also undertook a bus system reform that restructured the institutional arrangements for bus operations, formalizing and reorganizing its bus routes and implementing an extensive network of median bus exclusive lanes on city corridors.

Then in 2013, the SMG committed to "Vision 2030" for Seoul's transportation system. Under this new vision, the SMG set out to reinvent Seoul as a livable and mobile city without the need for private automobiles by the year 2030. To address sustainability issues and environmental protection within the transportation system, this new vision focused on

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[1] Global Green Growth Institute (GGGI). 2020. Green Deals to Accelerate Climate Action Post-COVID-19. Insight Brief No. 3. https://gggi.org/report/greendeal-to-accelerate-climate-action-post-covid-19_202010-4-2/

supporting pedestrians and cyclists, encouraging the use of shared mobility including public transit, and expanding the use of low-emission and eco-friendly vehicles.[2]

The COVID-19 pandemic has brought even greater momentum to the SMG's efforts to support active transport (i.e., walking and biking). Interest in active transport—seen as a green and health-friendly form of urban mobility—has been invigorated by the COVID pandemic. But the pandemic has also brought new challenges to promoting the use of public and shared transport. In 2020 during the pandemic, the Korean national government provided "distancing in daily life" guidelines that discouraged citizens from using public transit, such as bus and subway, when there were alternative modes.

This case study provides background information for discussion on how the SMG can take further steps to improve the resilience of its urban transport systems and reconcile its pre-pandemic vision for urban transport with new lessons-learned during COVID-19. Putting yourself in the shoes of the SMG decisionmakers, consider the following questions as you read through the material:
- What factors make urban transport systems more resilient?
- What reforms did the SMG undertaken prior to COVID-19 that allowed the system to be more resilient during the pandemic?
- What lessons can be learned about the resilience of Seoul's transport system during the COVID-19 pandemic and what measures can improve it? Are there measures that were undertaken to improve health that also strengthened the resiliency of the urban transport system to other shocks?
- What measures put in place in Seoul's public transit system in response to COVID could bring long-term benefits for the health of travelers? What measures are needed to maintain public trust and bring back riders to the system?
- Are current goals and investments supporting active transport sufficient? If not, how can they be expanded?

And considering your own city, how does the resilience of its transport system compare to the resilience of the transport systems in Seoul? What good practices from Seoul might be replicable in your own city?

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[2] Seoul Solution. 2016. "Vision 2030 for a Pedestrian-Friendly Seoul," November 18.
https://seoulsolution.kr/en/node/1769

SEOUL, SOUTH KOREA

Seoul is the largest city in Korea with a population of approximately 10 million people (19% of the entire population of Korea) and an area of 605 km^2. With an average population density of 16,500 people/km^2, Seoul is also one of the densest cities in the world.[3]

Seoul is comprised of twenty-five districts with the Han River bisecting the northern and southern halves of the city. Seoul is a polycentric city—with the historical and political center of the city in the Jongno and Jung districts; the financial center in the Yeouido precinct of the Yeongdeungpo district; and the economic center in the Gangnam district (see Figure 1).

Figure 1. Map of Seoul's 25 districts and major activity centers[4]
Historical and political centers marked in gold, financial center marked in green, and economic center marked in blue.
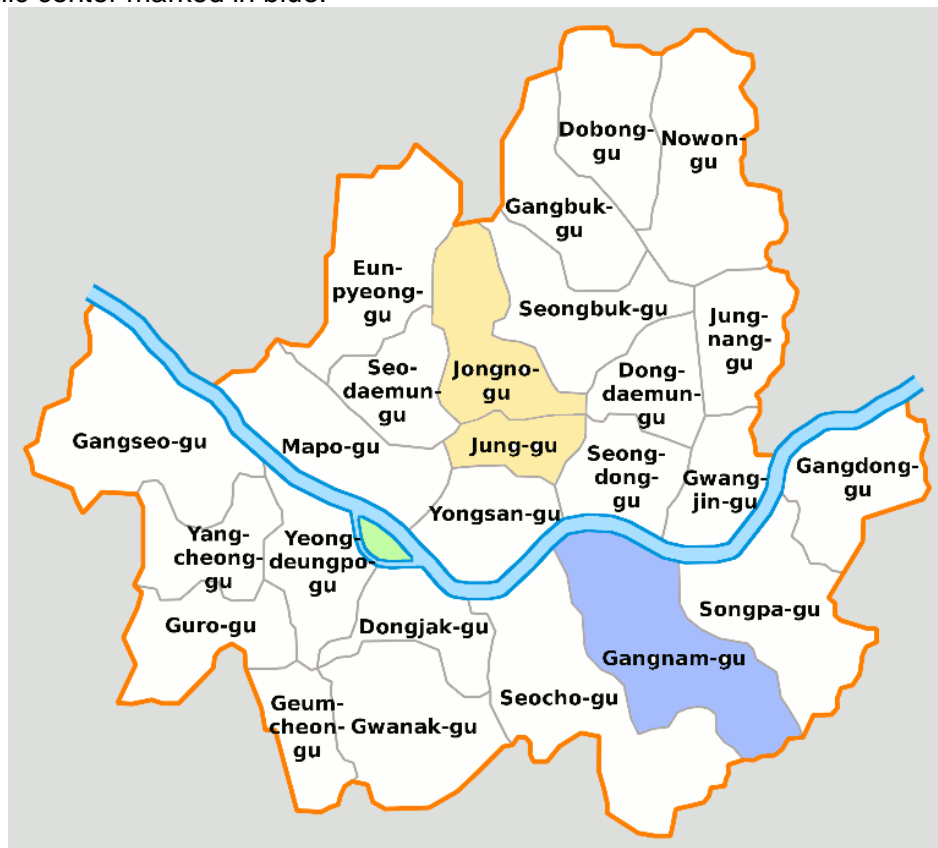
[3] "Suzuki, Hiroaki, Robert Cervero, and Kanako Iuchi. 2013. *Transforming Cities with Transit: Transit and Land-Use Integration for Sustainable Urban Development.* Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/12233

[4] Adapted from Wikimedia Commons. https://en.wikipedia.org/wiki/File:Map_Seoul_districts_de.png

EVOLUTION OF SEOUL'S URBAN TRANSPORT SYSTEM: BUILDING UP AND TEARING DOWN HIGHWAYS

During the 1960s and 1970s, Seoul experienced significant urbanization. Development of transportation and other urban infrastructure failed to keep up with the rapidly growing population, resulting in serious traffic congestion, environmental pollution, unauthorized settlements, and housing shortages. The SMG concentrated on building road infrastructure and public housing, replacing infrastructure damaged in World War II and building new capacity to meet the massive inflows of people to the city. It was also during this time that the first subway line opened in Seoul.

During the 1980s and 1990s, the SMG implemented a series of urban improvement and beatification policies, developing and densifying new areas of Seoul. The SMG completed a large number of transportation infrastructure projects—including lines 2 through 8 of the subway system and the construction of major arterial roads and urban expressways—to connect the growing number of urban areas.

Increased income level of Seoul citizens led to a tenfold increase in the number of cars between the 1980s and 2015. In the early part of that period, the SMG responded by building additional road capacity to meet growing demand. But in the early 2000s, the SMG's approach changed, and they began adopting urban management goals focused on the achievement of a smart and sustainable city. The SMG began to implement a diverse set of policy measures to reduce the use of passenger cars and increase the use of public and active transport. It was during this period that the SMG restored streams, parks, and public spaces in the historic city center. The SMG also digitalized its administrative services and developed other information technologies to respond to the increasing citizen demand for improved quality of life.

A major flagship transport project during this time was the removal of the Cheonggye Freeway, a high-volume elevated expressway that covered up the historic waterfront of Cheonggye Creek. When the 30-year-old highway's condition failed to pass a safety inspection in 2001, the SMG had to consider whether to reconstruct the highway (at an estimated cost of 93 billion won) or demolish it. The restoration became a major topic during the mayoral election campaign that year. And Lee Myung-Bak was elected Mayor of Seoul due, in large part, to a platform that promised the removal of the freeway and restoration of the Creek, enhancing Seoul's appearance and creating a recreational area for pedestrians.[5]

Before the launching of the demolition project, the SMG simulated the effects of the highway's removal on the area's traffic flows by taking measures to alleviate anticipated problems. Measures included improvements in the accessibility of public transit, reduction of nearby parking lots and increasing of parking fee, and the provision of real-time traffic information to detour the traffic heading to the areas. The main consideration was to decrease the use of passenger cars in the affected area so that remaining traffic could continue to flow at street level. The SMG also demolished many of its pedestrian

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[5] Congress for the New Urbanism (CNU). n.d. "Seoul | Cheonggye Freeway." https://www.cnu.org/highways-boulevards/model-cities/seoul
Seoul Solution. 2017. "Seoul Urban Regeneration: Cheonggyecheon Restoration and Downtown Revitalization," April 21. https://seoulsolution.kr/en/node/2374

overpasses and replaced them with crosswalks at the same places to enhance pedestrians' convenience.[6]

The success of the project was empirically demonstrated by collecting data on traffic flows and the environment both before and after the project. For instance, the Cheonggyecheon area reported a significant reduction in the concentration of local air pollutants, including fine dust (PM-10), NO_2, and volatile organic compound (VOC) shortly after the restoration project was completed. The heat island effect in the downtown also declined; the temperature of the Cheonggyecheon area before the restoration was 2.2℃ higher than the average of Seoul, but it declined to 1.3℃ after the restoration. And foot traffic in the area increased significantly, particularly on weekdays.[7]

VISION 2030

In December 2013, the SMG committed to Vision 2030 which laid out eleven commitments for improving the transport system to achieve a livable Seoul without relying on vehicles. Traditionally, roads were designed for vehicles; however, Vision 2030 emphasizes projects that dedicate road space to public transit, walking, and cycling. The eleven commitments of Vision 2030 were organized according to three core values: people, sharing, and environment (see Figure 2).[8]

1) **Creating a pedestrian-oriented environment:** The SMG committed to expanding pedestrian-only zones by doubling the coverage of sidewalks (from 10.13 million m^2 in 2014) and by closing roads on certain days. At the same time, they promised to extend public transportation-only zones and create promenades connecting tourist attractions, cultural areas, and shopping districts.

2) **Creating a bicycle-centered environment:** The SMG committed to increase bicycle-sharing services by expanding the coverage of the existing network and linking with bicycle-sharing services in nearby districts. They also promised to link neighborhoods with bicycle paths so citizens can easily cycle throughout Seoul. Bicycles in Seoul were branded as a new mode of public transportation.

3) **Improving road safety:** The SMG committed to comprehensively improve the traffic environment in all neighborhoods to ensure the safety of pedestrians, cyclists, and car users. One of the flagship measures was to implement a speed limit of 30km/h in all neighborhoods.

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[6] Seoul Solution. 2017. "Transition from the vehicle-oriented city to the pedestrian-friendly city," September 26. https://seoulsolution.kr/en/content/6307

[7] Seoul Solution. 2017. "Seoul Urban Regeneration: Cheonggyecheon Restoration and Downtown Revitalization," April 21. https://seoulsolution.kr/en/node/2374

[8] Ko, Joonho. 2015. *Seoul: Transport Vision 2030.* Urban Solutions, Case Study. https://www.clc.gov.sg/docs/default-source/urban-solutions/urb-sol-iss-6-pdfs/case-study-seoul-transport-vision.pdf
Seoul Metropolitan Government. n.d. *Seoul Transportation 2030.* https://seoulsolution.kr/sites/default/files/gettoknowus/Seoul%20Transportation%202030.pdf
Seoul Solution. 2016. "Vision 2030 for a Pedestrian-Friendly Seoul," November 18. https://seoulsolution.kr/en/node/1769
Seoul Metropolitan Government. n.d. "Seoul Transportation Vision 2030." http://english.seoul.go.kr/policy/traffic/seoul-transportation-vision-2030/

4) **Creating obstacle-free and inclusive transport:** To better serve the needs of the elderly and those with mobility impairments, the SMG committed to replacing all high-floor buses in the fleet (about 2022 or 27% of buses) with low-platform/low-entry buses. The SMG also aimed to increase the mobility of the disabled by offering more on-call taxi services.

5) **Constructing an efficient railway-centered public transit system:** The SMG committed to add railway express services where there are high point-to-point traffic volumes. In addition, the SMG committed to continuing to expand railway networks within cities (including light rail transit in more suburban areas) and higher-speed railway links between cities.

6) **Providing fast and convenient public transport services:** The SMG committed to complete a network of bus-only lanes, to provide diverse services to meet passengers' specific needs, to design bus lanes in a way that helps people have easy access to railway stations, to expand and revise late-night bus lanes, and to customize taxi services to help citizens get home safely.

7) **Encouraging shared mobility:** The SMG committed to developing a car-sharing program to reduce the share of private vehicles and decrease highway congestion.

8) **Reducing unnecessary trips:** The SMG adopted the goal to encourage citizens to refrain from using private vehicles as much as possible. As a means of achieving this goal, the SMG proposed studying the benefits and costs associated with a mileage-based congestion charge for private vehicles. To manage parking demand in Seoul, the SMG committed to minimizing the number of parking lots in and around new buildings or facilities. And to relieve rush hour traffic, SMG committed to promoting a flexible working hours system, including telework.

9) **Promoting the use of eco-friendly transport modes and infrastructure:** The SMG set out goals for gradually replacing nearly all buses, taxis, and even personal vehicles that pollute the air with low-emission and eco-friendly vehicles. The SMG explored the idea of 'solar ways' that produce energy at public transportation facilities, including bus stops, streetlights, soundproof walls, and pavements. And they committed to piloting rain and pollutant absorbent road pavements together with renewable pavements in road asset management and maintenance.

10) **Reducing congestion:** The SMG laid out plans to convert highways into underground tunnels and to dedicate ground-level space for public parks and bicycle roads. They committed to develop a traffic forecast alarm system to notify users of current or imminent traffic conditions and allow users to identify the best route, most effective mode of transport, and quickest travel time.

11) **Improving citizen awareness and better transport culture:** In carrying out transportation projects and relevant policies, the SMG committed to communicate with the public and build consensus. The SMG developed new monitoring and feedback systems to help collate feedback and minimize conflict, which often arises at initial stages of policy implementation.

Along with Vision 2030, the SMG set out the 2030 Triple 30 targets: a 30% reduction in automobile use (i.e., number of car trips), a 30% reduction in travel times by public transit, and an increase in green space ratio from 10% to 30% in Seoul's city centers.

With these 2030 triple 30 targets, the SMG expected to see a 10% increase in mode share by 'green' transport—public transit, walking, biking, and zero tailpipe-emission vehicles—from 70% to 80% by 2030 and a reduction in annual per capita greenhouse gas (GHG) emissions from transport from 1.2 tons to 0.8 tons.[9] This reduction in GHG emissions has co-benefits for public health and resilience, though these were not an integral part of the pre-COVID vision.

Figure 2. Overview of Seoul Vision 2030 Commitments and 2030 Triple 30 Targets
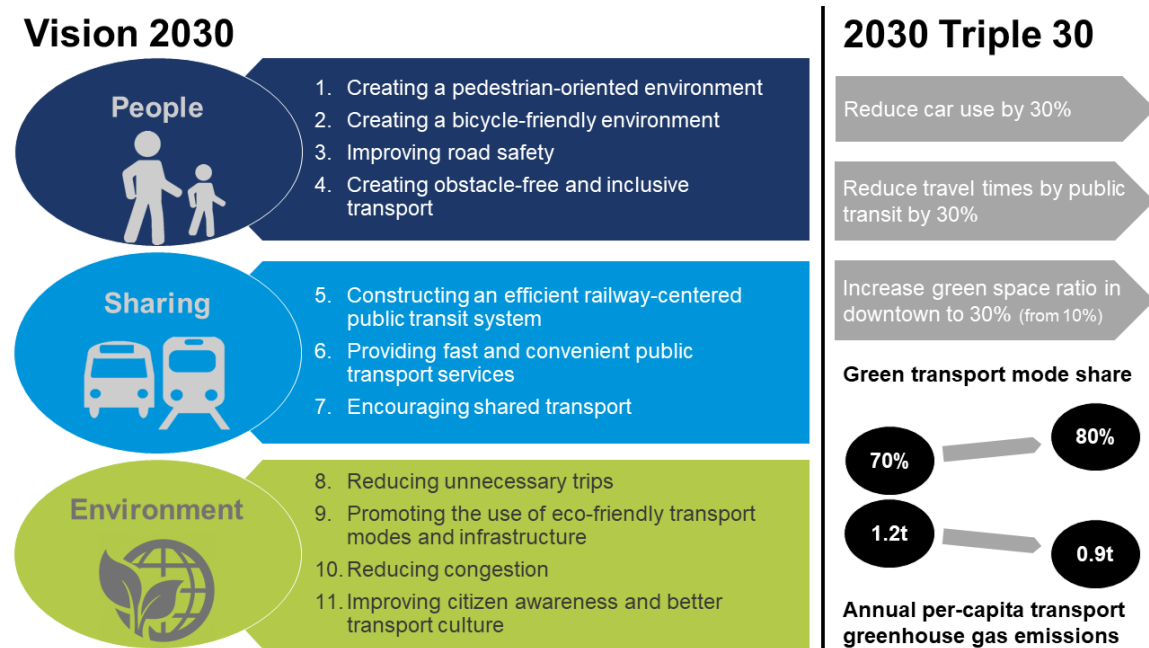
SEOUL'S TRANSPORT SYSTEM

Public Transit

In 2015, public transport served nearly 66% of average daily traffic in Seoul (estimated at 32 million trips)—with 40% being served by the metro system and 25% being served by the bus system. Recognizing the importance of public transit systems for the resilience, health, and sustainability of the city, the SMG continues to improve the coverage and quality of the public transit network.

Bus System

In the Seoul metropolitan area, around 7,400 buses operate on 356 routes, serving approximately 4 million passengers per day.

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[9] Seoul Solution. 2016. "Vision 2030 for a Pedestrian-Friendly Seoul," November 18. https://seoulsolution.kr/en/node/1769

In July 2004, the SMG embarked on a bus system reform that restructured its bus routes using a color-coded system of trunk (blue), feeder (green), inter-regional (red), and circular (yellow) lines:[10]

- Blue buses are trunk lines that run long-distance routes connecting among major urban centers of Seoul. 124 routes with 3,619 buses connect areas outside central Seoul to downtown Seoul. These buses focus on high-frequency and reliable service and increasingly run within median bus exclusive lanes.
- Green buses are feeder lines that operate on short distance routes and run at slower speeds than the trunk lines. These buses often provide first-/last-mile service for longer trips by trunk bus lines or metro. Therefore, they stop at most major subway stations and bus stations outside the center of Seoul.
- Red buses operate on nine express routes connecting Seoul and neighboring cities of Seoul with 229 buses.
- 27 yellow buses operate on four circular routes within downtown centers of Seoul. They have lower fares than green or blue buses and stop at railway stations, tourist sights, shopping and business areas, and blue bus stops which allow connections to areas outside downtown Seoul.

In addition to these regular services, the SMG also provides bus services on critical overnight routes. These routes reflect citizen demand and existing travel patterns late at night, determined by analyzing big data on taxi operations (600,000 pieces of GPS information) and cell phone use. As of July 2017, the overnight or "owl" bus system includes 70 buses on nine bus routes.[11]

As part of the bus system reform of 2004, the SMG adopted an open approach to Bus Rapid Transit (BRT) and began implementing an extensive network of median bus exclusive lanes on city corridors. As of 2020, there are 13 corridors with nearly 129 km of road with dedicated infrastructure. The open BRT system allows any bus to operate in the lanes for the portion of the route where dedicated infrastructure is available. The median bus exclusive lanes are primarily used by the blue trunk buses and red inter-regional buses. The open BRT system has boosted punctuality and speed, raising citizen satisfaction with Seoul's bus service.

Institutional arrangements for bus operations were also restructured. Since 2004, the SMG retains responsibility for planning/defining routes, coordinating and setting performance targets for operations, evaluating performance, and financial support for the system. Under performance- and route-based contracts, private companies are then responsible for bus operations, vehicle management, and management of the 17,630 drivers employed within the bus system.[12]

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[10] Seoul Metropolitan Government. 2015. *Seoul Public Transportation.* https://www.metropolis.org/sites/default/files/seoul_public_transportation_english.pdf

[11] Sung, Nak Moon and Mauricio O. Rios. 2015. "How is big data transforming transport in South Korea? *World Economic Forum, Fourth Industrial Revolution*, April 30. https://www.weforum.org/agenda/2015/04/how-is-big-data-transforming-transport-in-south-korea/

Seoul Urban Solutions Agency (SUSA). 2019. "Using Big Data to Design Night Bus Routes," *Development Asia,* October 3. https://development.asia/case-study/using-big-data-design-night-bus-routes

[12] Audouin, Maxime, Mohamad Razaghi, and Matthias Finger. 2015. "How Seoul used the T-Money smart transportation card to replan the public transportation system of the city; implications for governance of innovation in urban public transportation." Presentation at the *8th TransIST Symposium*, Istanbul Turkey, December. https://www.researchgate.net/publication/290574722

The SMG is also strongly encouraging the introduction of electric buses into its fleet. Already with a total of 460 electric buses in operation in the Seoul metropolitan area by the end of 2020, the SMG has plans to increase the number of eco-friendly buses to 3,000 and green shuttle buses to 470 by 2025.[13]

Urban Rail System

The Seoul urban rail system comprises as many as 22 rail lines and 746 stations connecting the whole metropolitan area of Seoul with the surrounding Gyeonggi Province.

There are nine main subway lines and one LRT line operated by Seoul Metro—a public corporation owned by the SMG—that carry 5.2 million passengers a day. Seoul plans to extend the existing subway lines and expand the light rail network to build a compact urban rail network of 441km and make the subway available within 10 minutes of walking anywhere in Seoul's 25 districts. These subway lines connect with regional rail lines operated by Korail, the national railway operator (see Figure 3).

Figure 3. Map of Seoul Metropolitan Area urban rail system[14]

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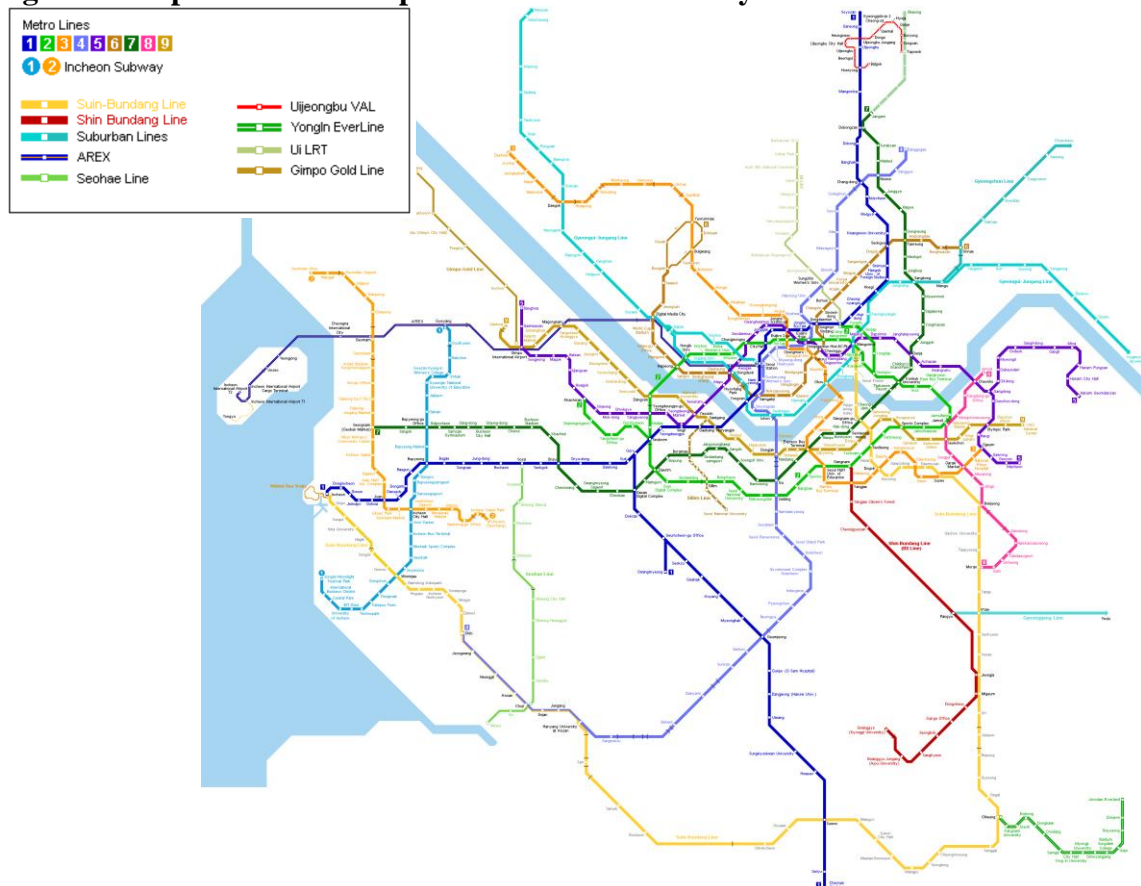
[13] Seoul Metropolitan Government. 2020. "Seoul Triples Number of Eco-friendly Electric Buses to Improve Air Quality," April 23. http://english.seoul.go.kr/seoul-triples-number-of-eco-friendly-electric-buses-to-improve-air-quality/?cp=3&cat=827

[14] R. Schwandl. 2021. Seoul Subway Map (including Incheon) via UrbanRail.net http://www.urbanrail.net/as/kr/seoul/seoul-map.htm

Transit Smart Card
The SMG introduced a transit smart card (called "T-money") in 2004 that can be used to pay for all bus, subway, and taxi fares as well as congestion and express way tolls. The smart card offers discounts on transfers between buses and subways and can be used to pay at convenience stores that also reload the fare card. T-money has high uptake, with the SMG reporting 100.00% of subway, 98.96% of bus, and 70.43% of taxi users paying by the smart card in 2018. In addition to paying for transport fares, T-money can also be used at many local markets like a credit card. To encourage shop owners to receive payments via the T-money card, the SMG distributed card readers to shops in the market and subsidized 70% of commission fees for small payments.[15] With its high uptake and diverse use cases, T-money has helped boost citizens' convenient use of the city's public transit services and encouraged use of local, small businesses.

Car-Sharing
In 2013, the SMG launched a car-sharing program called "Nanum Car." In partnership with private car-sharing operators, the program provides for-rent gasoline-powered and electric vehicles to individuals for temporary use. The program was implemented with the goal of reducing the need for Seoul residents to own their own car, reducing traffic congestion, resolving parking issues, and mitigating pollution.

In its first phase (2013-2015), the program partnered with two operating companies to deploy 3,000 gasoline-powered vehicles, reaching 72,600 users. At the same time, SMG began preparing for electric car-sharing by building-out infrastructure for charging stations. By 2014, they had installed 850 outlets in public parking lots that supported a fleet of 1,916 cars.[16] In its second phase (2016-2018), the car-sharing system increased the number of total vehicles (both gasoline-powered and electric) to 4,700 and the user base nearly tripled to 210,000. And in its third phase, the SMG opened the system to two additional operating companies and plans to double the number of vehicles to 10,000 by 2022. SMG supports the program by dedicating spaces in municipal public parking lots for the car-sharing vehicles.[17]

Active Transport

In 2019, active transport—i.e., walking and cycling—accounted for 4.2% of door-to-door trips in Seoul. In addition, active transport is a primary way for accessing public transit trips. Thus, mode shares not accounting for these important first-/last-mile journeys understate the importance of active transport in Seoul.

Bicycle Lanes
By 2020, the SMG had implemented 940 km of bicycle lanes, with plans to reach 1,330 km by 2030. The SMG aims to create "cycle rapid transport" supported by a network of main and branching bicycle lanes along which bicycles can move safely and quickly

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[15] Seoul Metropolitan Government. 2015. "Shop with T-money or credit card at Seoul traditional markets," January 14. http://english.seoul.go.kr/shop-t-money-credit-card-seoul-traditional-markets/

[16] Seoul Solution. 2017. "Shared Transport: Car Sharing in Seoul (Nanum-Car)," July 24. https://www.seoulsolution.kr/en/node/3462

[17] Seoul Metropolitan Government. 2019. "Seoul to launch the third phase of sharing car (Nanum Car) program, making it a semi-public transportation means by 2022," July 1. http://english.seoul.go.kr/seoul-to-launch-the-third-phase-of-sharing-car-nanum-car-program/

without danger of colliding with other means of transport.[18] This means creating bicycle lanes that are totally separated from the roadway. Existing bicycle lanes that are right beside vehicle traffic lanes will be raised to be the same height as that of the sidewalk. The trees along the streets that block passing will be transplanted and the width of the road will be kept the same (see Figure 4).

Figure 4. Development of bicycle lanes[18]

Bicycle-Sharing

The Seoul public bicycle-sharing service, Ttareungi, is a docked (or station-based, unattended) public bicycle rental system available to anyone at any time. As of 2020, the system included 1,540 rental stations and as many as 37,500 bicycles.[19]

Sidewalks and the Pedestrian Environment

In 2013, the SMG revisited their approach to sidewalk provision and regulation to improve the travel experience of pedestrians. They found that, while 78% of all roads in downtown Seoul complied with the minimum 2-meter width required by regulations, pedestrians continued to experience considerable inconvenience from bollards, ventilation openings, roadside trees, and other obstacles in the sidewalk right-of-way. Furthermore, pedestrians often encountered illegally parked vehicles. Therefore, the SMG put out the goal to double the surface area of sidewalks in downtown areas from 10.13 km^2 to over 20.00 km^2.[20]

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[18] Seoul Metropolitan Government. 2020. "Seoul Creates Commuting Lane for Bicycles by Repairing Existing Bicycle Lanes," September 7. http://english.seoul.go.kr/seoul-creates-commuting-lane-for-bicycles-by-repairing-existing-bicycle-lanes/?cp=3&cat=827

[19] Seoul Metropolitan Government. 2020. "Introducing New QR-type Ttareungi," March 2. http://english.seoul.go.kr/introducing-new-qr-type-ttareungi/

[20] Seoul Metropolitan Government. n.d. "Seoul Transportation Vision 2030." http://english.seoul.go.kr/policy/traffic/seoul-transportation-vision-2030/

Since 2013, the SMG has made significant progress in meeting its goal to increase the surface area and quality of sidewalks. Much of this has been achieved by renovating road space to pedestrian space. For example, in 2015, the SMG closed a 1 km highway overpass around Seoul Station because it no longer met infrastructure safety and resilience standards. Rather than demolish the roadway, the SMG decided to turn it into a park for pedestrians, which provides gardens and improves walking times around Seoul's central transit station. The project—called Seoullo 7017—created a walking tourism network with 17 pedestrian roads that opened in 2017.[21]

Another example is Sejong-daero—once a 12-lane road that catered only to vehicles. The project, which opened in 2021, reduced the number of lanes considerably. The recovered space was used to create pedestrian areas twice as large as Seoul Plaza along with bicycle lanes and green spaces filled with various trees and flowers. Branded as a "pedestrian forest path," the renovation of Sejong-daero is expected to become an example for further improvements in Seoul that embrace culture, history and landscaping, and link businesses, services, and people. The construction of the pedestrian forest path on Sejong-daero did not lead to traffic congestion; the speed of passing vehicles is the same as before the construction.[22]

New regulations are also supporting the quality of pedestrian environments by reducing obstacles and protecting pedestrians in their right-of-way and at intersections. Electric scooters, motorcycles, and bicycles are required to be driven off sidewalks in consideration of pedestrians. An amendment of the Enforcement Decree of the Road Traffic Act has been requested for the immediate towing of illegally parked personal mobility on sidewalks that hinder pedestrians without proactive fines.[23]

The SMG plans to enhance the safety of pedestrians by installing more than 30 additional crosswalks near zones with high traffic incidents involving pedestrians and safety warnings at hazard areas where the installation of a crosswalk is pending. Because of the large main block size in many urban centers of Seoul, highly visible mid-block pedestrian crossings that align with alleyways are an important intervention for improving walking conditions and safety. Diagonal crossings will also be installed at twenty-five locations to provide a safer and more convenient walking environment for pedestrians.[24]

Speed Limits

Complementing the SMG's commitment in Vision 2030 to implement safe speed limits and reduce road traffic fatalities and injuries in Seoul, Korea's Ministry of Land, Infrastructure and Transport piloted the "Safe Speed 5030" initiative in 2018. The initiative reduced speed limits to 50 km/hr on main roads in downtown areas and 30 km/hr on side streets

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[21] Seoul Metropolitan Government. 2018. "Seoullo 7107 Overview" http://seoullo7017.co.kr/SSF/ENG/H/PRO/010/01010.do#

[22] Seoul Metropolitan Government. 2020. "Completion of Pedestrian Forest Path on Sejong-daero and Grand Opening in January 2021," December 30. http://english.seoul.go.kr/completion-of-pedestrian-forest-path-on-sejong-daero-and-grand-opening-in-january-2021/?cp=2&cat=827

[23] Seoul Metropolitan Government. 2021. "Seoul Makes Full-Scale Launch to Establish Pedestrian-Safe Culture in 2021," March 9. http://english.seoul.go.kr/seoul-makes-full-scale-launch-to-establish-pedestrian-safe-culture-in-2021/?cat=827

[24] Seoul Metropolitan Government. 2020. "Pedestrian-Friendly Diagonal Crossings at 25 Locations in Seoul," December 10. http://english.seoul.go.kr/pedestrian-friendly-diagonal-crossings-at-25-locations-in-seoul/?cp=2&cat=827

nationwide. [25] In addition to the expanded implementation of the Safe Speed 5030 initiative, the SMG announced that it will lower the speed limit to 20 km/hr for priority zones (such as school zones) and in residential areas.[20] While these measures have already resulted in reductions in pedestrian deaths from vehicular crashes, pedestrians still represent a large share of traffic-related deaths, highlighting the importance of a safe systems approach to pedestrian and cyclist environments.

COVID-19 RESPONSE

During the pandemic, the Korean national government provided "distancing in daily life" guidelines that discouraged citizens from traveling for non-essential reasons and from using public transit, such as bus and subway, when there were alternative modes.[26] In Seoul, public transport use dropped significantly during the pandemic. In March 2020, passengers in Seoul's public transport system were down by 34.5% compared to January. [27] While ridership numbers have begun to recover, in the first year of the pandemic bus and train operators saw persistently lower ridership and revenues than in years pre-pandemic. Bus operators saw an overall reduction in ridership of 23.6% resulting in a loss of revenue of around USD 500 million and subway ridership fell by 27.4% compared to the previous year, causing a deficit of roughly USD 850 million from lost fares and increased operating expenses from COVID-19-prevention measures.[28]

To protect remaining passengers, Seoul Metro rolled out a suite of measures to mitigate the risk of viral transmission in public transport vehicles and stations. The most impactful of these measures that comply with emerging best practice included:

- **Reducing crowding:** Seoul Metro established guidelines for managing congestion levels to provides adequate space for passengers to maintain physical distancing. To reduce congestion on the bus system, operators can actively customize the service based on the congestion level. When congestion reaches elevated levels, frequencies are increased and a maximum of 152 extra buses can be implement in rush hour. Real-time occupancy levels were provided to public transit passengers so that users can monitor congestion levels through a smartphone application or through the Bus Information Terminals (BIT) at bus stops.[24]

[25] Korea Bizwire. 2021. "Revamped Traffic Laws Expected to Reduce Traffic Accident Fatalities," March 26. http://koreabizwire.com/revamped-traffic-laws-expected-to-reduce-traffic-accident-fatalities/185771

[26] Lee, Seonhwa. 2020. "How South Korea is Managing Public Transportation under COVID-19," June 30. *Moviliblog*, InterAmerican Development Bank. https://blogs.iadb.org/transporte/en/how-south-korea-is-managing-public-transportation-under-covid-19/

[27] ICLEI Sustainable Mobility. 2020. "COVID-19: Focus on cities and transport responses – South Korea," April 27. https://sustainablemobility.iclei.org/covid-19-focus-on-cities-and-transport-responses-south-korea/ Park, Jewel. 2020. Changes in subway ridership in response to COVID-19 in Seoul, South Korea: Implications for social distancing. *Cureus*, 12(4): e7668. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7163336/

[28] Yonhap. 2021. "Seoul's public transport ridership fell sharply last year due to COVID-19: data," *The Korea Herald,* February 13. http://www.koreaherald.com/view.php?ud=20210213000058

- **Enforcing mask wearing:** Masks were required on public transit during peak times of congestion and compliance with the rule reached 95%.[29] A $100 fine was enforced for entering a public transit vehicle without a mask.
- **Maintaining good ventilation:** Perhaps most important for reducing the spread of the virus and maintaining the safety of passengers traveling by public transit during the pandemic is the quality of ventilation systems on trains and buses.[30] Pre-pandemic, Seoul Metro had already started taking steps to improve ventilation of subway stations and vehicles in order to improve air quality and the health of its passengers. During the pandemic, they increased these efforts. They installed 840 air quality sensors in stations and trains. The data collected from the sensors is used to improve ventilation and cleaning processes.[31]
- **Cleaning surfaces:** Seoul Metro rigorously sterilizes surfaces in public transport vehicles and stations that people frequently touch, and the operation hours of the subway were shortened by an hour to allow for full disinfecting protocols at the end of each day.[32]

Early on in the pandemic, the SMG also experimented with higher-tech and more aggressive measures to reduce viral transmission. However, these measures proved to be of limited effectiveness and expensive to implement and maintain.
- They installed ten high-tech bus shelters with air conditioning and ultraviolet lamps to kill viruses.[33] At these high-tech bus stops, automated thermal-imaging cameras connected to automatic doors, which would open only if a passenger's temperature was detected to be below 37.5 C.[29]
- To screen passengers for potential symptoms of COVID-19, Seoul Metro implemented temperature checks on the rail system early in the pandemic and installed thermal cameras, reserving the right to refuse entrance to passengers with high fever and administer COVID-19 tests. However, subsequent studies have suggested that daily temperature checks are insufficient as a primary means of detection to reduce transmission of COVID-19.[34]

[29] Sun, Changwoo. 2021. The Role of Cities as the First Responder to Pandemics: Focusing on the Case of the Seoul Metropolitan Government's Response to the COVID-19, *Journal for Peace and Nuclear Disarmament, 4.* https://doi.org/10.1080/25751654.2021.1882773

[30] Pardo, Carlos Felipe, Silvana Zapata-Bedoya, Andrea Ramirez-Varela, Daniel Ramirez-Corrales, Jairo-José Espinosa-Oviedo, Darío Hidalgo, Nestor Rojas, Catalina González-Uribe, Juan David García, and Zulma M. Cucunubá. 2021. COVID-19 and Public Transport: An Overview and Recommendations Applicable to Latin America. Infectio, 25(3). http://dx.doi.org/10.22354/in.v25i3.944

[31] Moey, Fraulein. 2020. "How Seoul Metro Improves Indoor Air Quality in Subway Stations," ThermoFisher Scientific Blog, November 3. https://www.thermofisher.com/blog/identifying-threats/how-seoul-metro-improves-indoor-air-quality-in-subway-stations/

[32] World Health Organization. 2020. "Seoul Metro rebuilds passenger confidence through hygiene measures and strong staffing protocols," October 28. https://www.who.int/news-room/feature-stories/detail/seoul-metro-rebuilds-passenger-confidence-through-hygiene-measures-and-strong-staffing-protocols

[33] Agence France-Presse. 2020. "South Korea installs anti-virus bus shelters with temperature sensors and UV lamps," *The Guardian,* August 12. https://www.theguardian.com/world/2020/aug/13/south-korea-installs-anti-virus-bus-shelters-with-temperature-sensors-and-uv-lamps

[34] Facente, Shelley N., Lauren A. Hunter, Laura J. Packel, Yi Li, Anna Harte, Guy Nicolette, Shana McDevitt, Maya Petersen, and Arthur L. Reingold. 2021. Feasibility and effectiveness of daily temperature screening to detect COVID-19 in a prospective cohort at a large public university. *BMC Public Health,* 21, 1693.

Both simulation studies[35] and ex-post analyses of transmission from contact tracing data in Seoul have shown that these measures, in combination with robust city-wide testing and quarantine policies, are successful in keeping public transport passengers safe.[36]

While the COVID-19 pandemic depressed public transit use and created new operational challenges for Seoul's bus and subway systems, it also brought new momentum to Seoul's efforts to support active transport—walking and biking. Interest in active transport, seen as a green and health-friendly form of urban mobility, has been invigorated by the COVID pandemic. In Seoul, the use of Ttareungi shared bikes surged; the number of Ttareungi rentals in 2020 was 23.7 million, up by 4.67 million trips (24.6%) compared to 2019.[37] To support continued use of the public bikeshare system, bicycles and rental stations throughout Seoul are disinfected every day and hand sanitizer dispensers were installed at every rental station. Additionally, on March 1, 2020, Seoul began the rollout of bicycles that can be rented by scanning a QR code to reduce the need to touch shared equipment that may transmit the COVID-19 virus.[38] Responding to the surge in interest in active transport and making use of the fact that traffic levels on Seoul streets temporarily decreased during the pandemic,[24] the SMG accelerated and expanded commitments to expanding bike path networks.[39]

[35] Ku, Donggyun, Chih Yung Yeon, Seung Jae Lee, Kyu Hong Lee, Ki Yeon Hwang, Yuen Chong Li, and Sze Chun Wong. 2021. Safe traveling in public transport amid COVID-19. *Science Advances,* 7(43). https://doi.org/10.1126/sciadv.abg3691

[36] Public transit smart card information was used as part of the city's extensive contact tracing system. The system allowed the SMG to track the routes of potentially infected passengers and notify, test, and quarantine other passengers who may have been exposed.
Lee, Sang-Hoon. n.d. "CoVID-19 Contact Tracing System." https://olc.worldbank.org/system/files/1-3.%20COVID-19%20Contact%20Tracing%20System_0.pdf
Fendos, Justin. 2020. "How Surveillance Technology powered South Korea's Covid-19 response," *TechStream,* April 29. https://www.brookings.edu/techstream/how-surveillance-technology-powered-south-koreas-covid-19-response/

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[39] Lee, Sung-Eun. 2020. "Seoul vows massive expansion of bike path network," *Korea JoongAng Daily*, June 15. https://koreajoongangdaily.joins.com/2020/06/15/national/socialAffairs/seoul-bike-cycle-routes/20200615184807261.html

DISCUSSION QUESTIONS

Building cities that are inclusive, resilient, healthy, and sustainable requires intensive policy coordination and investment choices both at the national and local level. Many of the elements aimed at reducing GHG emissions in Vision 2030 have co-benefits for public health and resilience, though these were not an integral part of the pre-COVID vision.

In the wake of COVID-19, key questions for the SMG decisionmakers to consider include:
- What factors make urban transport systems more resilient?
- What reforms did the SMG undertaken prior to COVID-19 that allowed the system to be more resilient during the pandemic?
- What lessons can be learned about the resilience of Seoul's transport system during the COVID-19 pandemic and what measures can improve it? Are there measures that were undertaken to improve health that also strengthened the resiliency of the urban transport system to other shocks?
- What measures put in place in Seoul's public transit system in response to COVID could bring long-term benefits for the health of travelers? What measures are needed to maintain public trust and bring back riders to the system?
- Are current goals and investments supporting active transport sufficient? If not, how can they be expanded?

And considering your own city, how does the resilience of its transport system compare to the resilience of the transport systems in Seoul? What good practices from Seoul might be replicable in your own city?

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